



STORM SURGE TOOLS AND INFORMATION: A USER NEEDS ASSESSMENT

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I. Introduction

The hurricanes of 2004 and 2005 offer vivid evidence of the devastation that storm surge can inflict on coastal communities. Recognizing the importance of timely and accurate forecasts in reducing these impacts, the National Oceanic and Atmospheric Administration (NOAA) created an internal Storm Surge Leadership Team in November 2004 to assess the current state of storm surge models, information resources, and decision-support tools.

In January 2005, the Storm Surge Leadership Team convened a needs assessment working group consisting of individuals from the National Weather Service (NWS), the National Ocean Service (NOS), Sea Grant, and the Federal Emergency Management Agency (FEMA). Its goal was to consult with state- and local-level users of storm surge forecasts, as well as academia and the private sector, to identify specific areas for improvement within NOAA's models, decision-support tools, and information resources. Given the short time frame for this effort, the team triangulated information from multiple data sources to identify strategically important areas where NOAA could strengthen its storm-surge-related activities. The assessment consisted of three phases of data collection and analysis:

Phase I – Scoping Interviews and Literature Review: A series of interviews were conducted with key professionals from within NOAA, FEMA, professional associations, state and local governments, nongovernmental organizations, and the private sector to identify pressing issues and critical needs. Members of the needs assessment team also reviewed published studies and reports to consolidate existing evaluations of storm surge models and forecast products. This information was synthesized to generate a core list of questions and concerns for in-depth investigation during Phases II and III.

Phase II – On-line Needs Assessment: Members of the needs assessment group worked collaboratively with staff members from the Coastal Resources Center at the University of Rhode Island (URI) to develop and administer an on-line storm surge needs questionnaire. The assessment instrument was sent to 552 professionals and was also distributed to additional users through the Association of State Floodplain Managers (ASFPM) and regional NWS Weather Forecast Offices (WFOs). URI received 254 responses to the on-line assessment. Statistical analysis and data display was then performed using SPSS software.

Phase III – Focus Group Sessions: To complement and verify information collected during Phases I and II, the needs assessment team conducted focus group sessions with professionals from federal, state, and local government agencies, academia, the private sector, and the media, who worked on storm-surge-related issues. Sixty-one individuals representing 10 states participated in focus group events held in Stamford, Connecticut; Cambridge, Massachusetts; and Panama City, Florida.

The issues and needs identified by individuals who contributed input during all three phases were consolidated to develop the characterization of the most pressing storm-surge-related concerns outlined in this report.

II. User Characteristics and Existing State of Knowledge

The following section describes the demographic characteristics of the professionals who responded to the on-line assessment and participated in the focus group sessions. This material provides a framework for understanding the population of users whose input was used to formulate the findings and recommendations in this report.

User Demographics and Characteristics

One of the primary objectives of the needs assessment working group was to gather input from the full range of professionals who utilize storm surge information to support management activities. Throughout the assessment process, individuals from all levels of government shared their insights about coastal flooding from storm surge. Although the majority of these contributors were from the public sector, individuals from port authorities, the insurance industry, consulting firms, professional associations, academia, and the media also responded to the on-line assessment and attended the focus group sessions.

Members of the needs assessment team recognized that many private-sector organizations utilize storm surge information in their professional activities. Nonetheless, data collected during Phase I indicated that these private-sector users rely primarily on state and local government agencies to supply them with these data. Given this finding, the team focused on identifying relevant individuals from these governmental agencies when assembling the list of recipients for the on-line assessment. Of the 254 respondents to the questionnaire, 75 percent were from state and local government agencies (see figure 1).¹

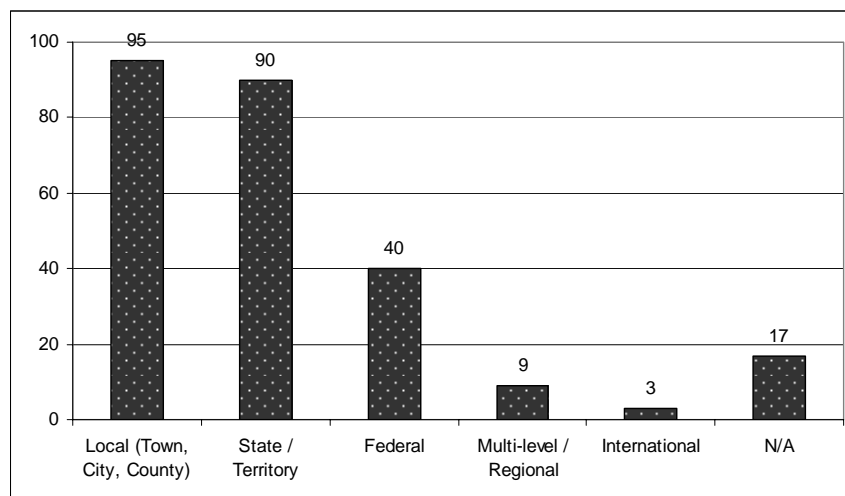


Figure 1: Number of respondents to the on-line needs assessment by level of government (n=254)

¹ Respondents in the N/A category represented academia, nongovernmental organizations, the private sector, and professional associations.

Professionals addressing storm surge issues across the United States responded, with the highest number of individuals coming from states in the Southeast and the Gulf of Mexico regions² (See figure 2).

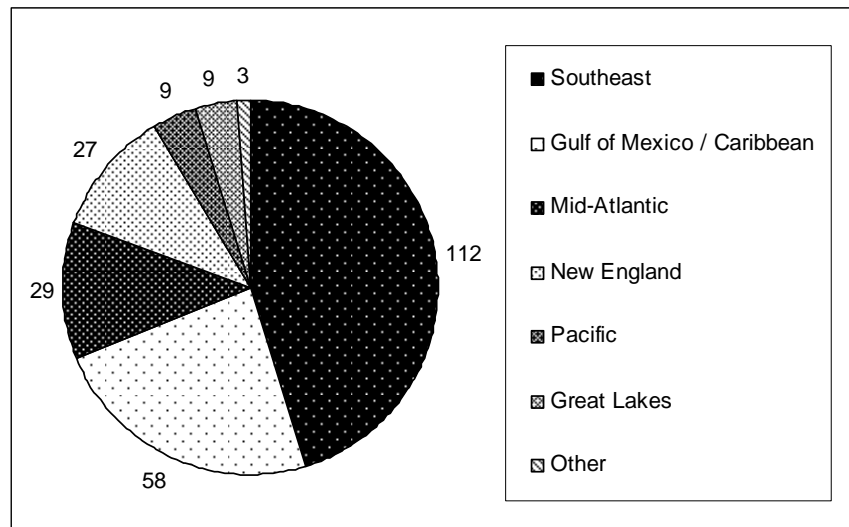


Figure 2: Number of respondents to on-line needs assessment by geographic region (n=254)

Given the large number of respondents from the Southeast, the needs assessment team chose to hold two focus group sessions in the Northeast and one in the Gulf of Mexico to capture potential geographic differences in user needs. Seventeen professionals from New Jersey, New York, and Connecticut attended the session in Stamford, Connecticut; thirteen individuals from Rhode Island and Massachusetts participated in the Cambridge, Massachusetts, event; thirty-one individuals from Louisiana, Mississippi, Alabama, Florida, and Georgia attended the Panama City workshop.

Although the team hoped to include more input from the Pacific and Great Lakes states, the short timeline and logistical constraints limited data collection in these regions. Responses to the on-line assessment received from these areas suggest that storm surge is also an issue of concern in the Pacific and Great Lakes states. This illustrates that improvements in storm surge forecasts and decision-support tools will benefit these users as well as those located along the East Coast.

One of the principal findings from Phase I was that a wide range of professionals beyond the traditional emergency management community use information about coastal flooding from storm surge. To better understand this range of users, respondents to the on-line assessment were asked to identify the one category that best reflected the type of organization they worked for (See figure 3). The largest number of respondents selected emergency management, followed by planning, land use, natural resource management, and Sea Grant/extension.

² The distribution of responses by region was influenced by the larger number of users from the Gulf of Mexico and southeastern states who received the on-line questionnaire. Given the limited time available to generate accurate lists of users and analyze the data collected, the needs assessment team made the strategic decision to focus on collecting information from users located in the Southeast and Gulf Coast states.

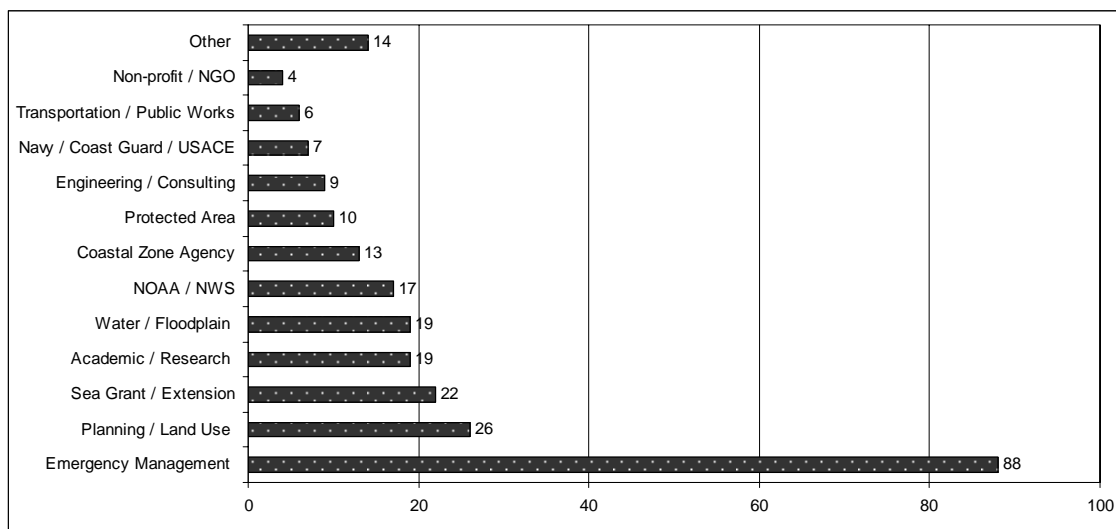


Figure 3: Number of respondents to on-line needs assessment by category of user (n=254)

Information collected throughout the needs assessment process suggests that many management agencies could be categorized under more than one of these categories. Although a number of the needs identified in this report have been broken down by user groups, this separation was done solely for analytical purposes. A statistical analysis of the responses of individuals from the planning, floodplain, coastal zone, and extension user types revealed that their needs exhibited strong similarities. Given these patterns, the answers from respondents in these four categories were combined for comparison with those who identified themselves as emergency managers. This analysis was done to emphasize differences in the issues and data needs of professionals using storm surge information for distinct types of management activities.

Data collected throughout the needs assessment process illustrate that storm surge planning and real-time response activities are interrelated. This finding highlights the need for tools and information that can support these different types of management efforts. Given the range and diversity of users relying on NOAA storm surge products, it is important that the agency consider the needs of the full range of professionals addressing storm surge issues during the development of new forecast and decision-support tools.

Existing Knowledge about Storm Surge

Assessing both the current state of knowledge about storm surge and the use of existing tools and information was the first step in identifying data gaps and high-priority needs. Seventy-eight percent of respondents to the on-line assessment indicated that coastal flooding from storm surge was a very important issue in their locale, and this pattern was reflected across types of users and geographic regions (see figure 4).

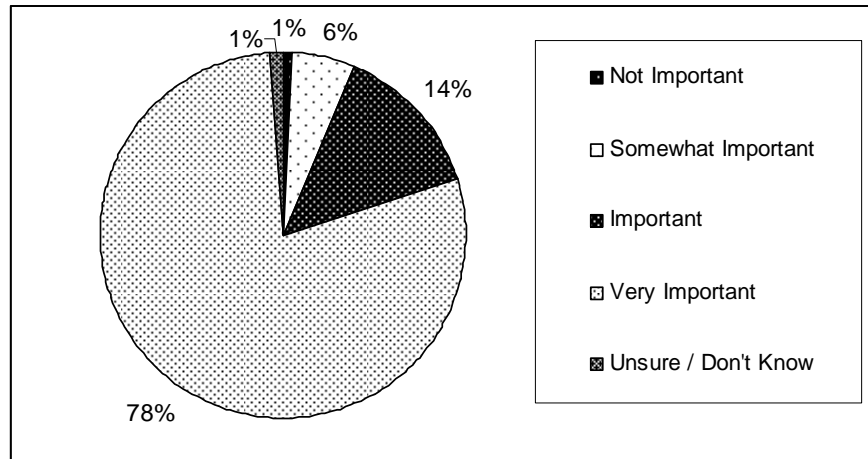


Figure 4: Respondents' assessment of the importance of coastal flooding from storm surge (n=254)

Respondents to the on-line questionnaire were also asked to rate their own level of knowledge about storm surge, as well as that of the public, elected officials, and other professionals at their agency. Ninety-eight percent of these individuals had some or extensive knowledge about storm surge, suggesting that these respondents are an informed group of professionals from which to gather input. In contrast, these individuals indicated that both the public and elected officials had considerably less knowledge about storm surge (See figure 5). This suggests a need for expanding outreach and education activities to ensure that policy makers and the public understand the threats and risks associated with coastal flooding from storm surge.

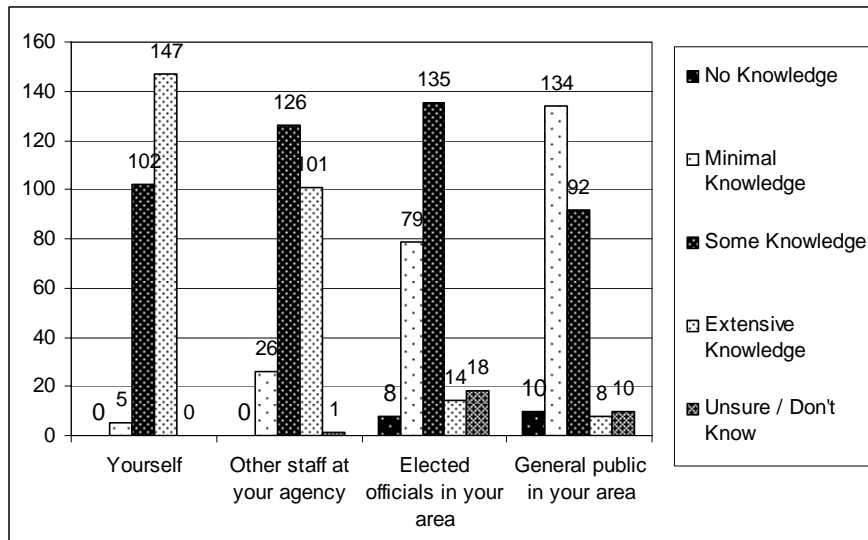


Figure 5: Level of knowledge about coastal flooding from storm surge (n=254)

These disparities among managers, elected officials, and the public in their understanding of storm surge were reinforced during the regional focus group sessions. In both the Gulf of Mexico and Northeast workshops, participants consistently cited a need for new and innovative ways for displaying and disseminating information so that coastal communities could better understand both their vulnerability to storm surge and the appropriate responses to these threats.

Data from both the on-line assessment and the focus groups pointed to the overuse of technical terminology and language, unclear graphical outputs, and confusion regarding where to access data as factors that limit the ability of the public and elected officials to understand the potential impacts from storm surge. For managers themselves, inconsistency in the use of different vertical datums and the inability to precisely predict the locations that would be flooded during storm events constrain local and state agencies' efforts to make informed decisions about issues ranging from land use permitting to evacuation during storm events.

When asked about current outreach efforts, less than half the respondents thought that these activities were either moderately or very effective, and 20 percent stated there was either no outreach in their area or it was not effective at all (See figure 6).

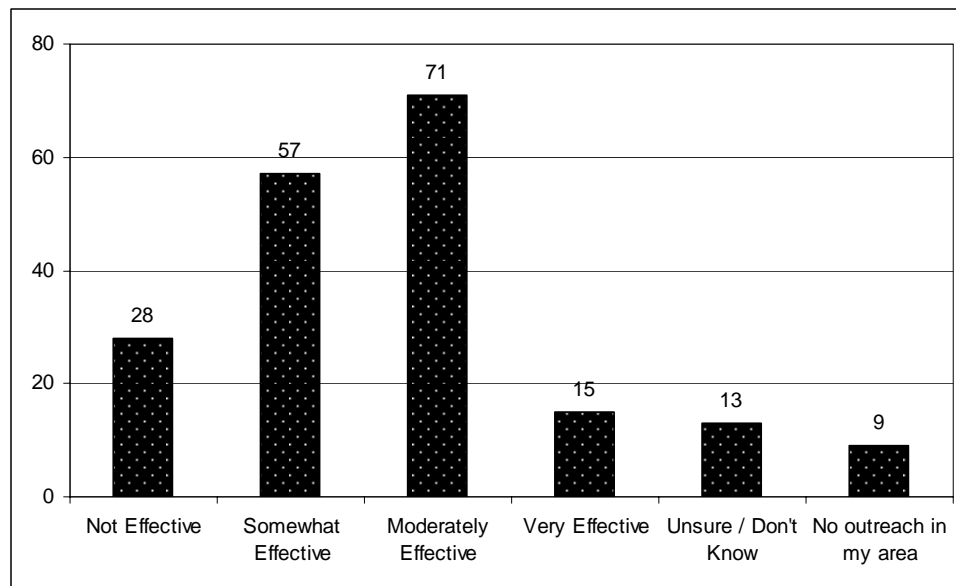


Figure 6: Effectiveness of outreach about coastal flooding from storm surge (n=193)

Participants in the focus group sessions frequently expressed a need for technical assistance on how to incorporate storm surge information into outreach and education activities. Unfortunately, many of these professionals were unfamiliar with the full range of NOAA storm surge products and information resources.

The needs assessment process identified NWS Weather Forecast Offices (WFOs) as one of the most important sources of support. Participants felt that further strengthening the WFOs' outreach and communication activities could help increase access to storm surge information and raise awareness about storm-surge-related threats. Information from the focus group sessions also highlighted a need for increased collaboration with local media when designing forecast outputs and outreach materials, since elected officials and the public look to television meteorologists for information about coastal flooding.

These findings indicate that NOAA could have an immediate positive impact on state and local management efforts by strengthening its outreach and education activities, utilizing SLOSH (Sea, Lake, and Overland Surges from Hurricanes) model data, and other technical resources to increase both elected officials' and the public's awareness of their communities' vulnerability to coastal flooding from storm surge.

Adapting Storm Surge Information to Changing Coastal Conditions

Rapid development and changes in the physical and social characteristics in coastal areas have significantly influenced the nature and extent of coastal flooding from storm surge. Nearly 60 percent of respondents to the on-line assessment stated that information about coastal flooding from storm surge had not been updated regularly enough to account for these changes (figure 7).

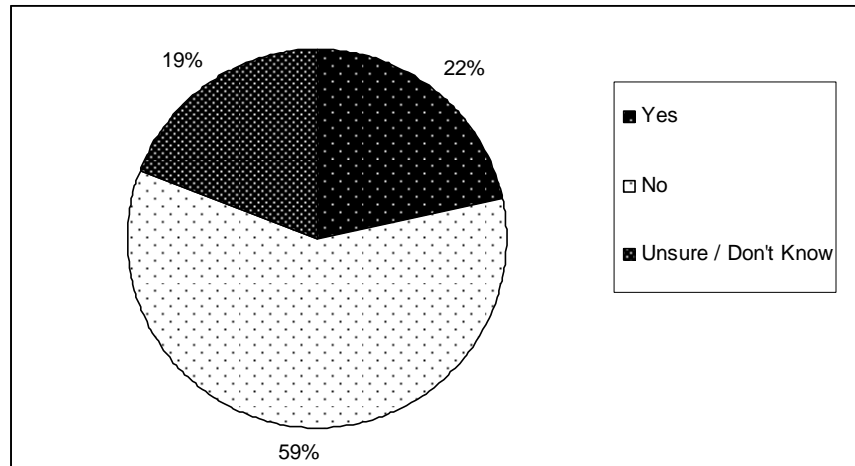


Figure 7: Has information about coastal flooding from storm surge been updated regularly enough to account for changes in coastal conditions in your area? (n=198)

The Department of Homeland Security (DHS) Federal Emergency Management Agency (FEMA) map modernization effort is an important step forward in addressing this deficiency in baseline information about the social and physical conditions on the coast. The professionals from FEMA who participated in all three of the focus group sessions emphasized the importance of cooperation between FEMA and NOAA to support the updating of maps and other tools used to plan for coastal flooding from storm surge. Results from the needs assessment indicate that updating storm surge data to account for changes in coastal conditions is one of the highest priority needs.

Interagency Collaboration

Throughout all three phases of the needs assessment process, management professionals indicated a need for increased collaboration among federal, state, and local agencies. Results illustrate that a wide range of federal, state, and local agencies, private-sector organizations, and universities collect data about different aspects of coastal flooding from storm surge. Users felt that FEMA, NOAA, the U.S. Geological Survey (USGS), and the U.S. Army Corps of Engineers (USACE) needed to build upon existing partnerships to improve the delivery of storm-surge-related information.

Participants in the Northeast focus group sessions suggested that some local planning and emergency management agencies have independently collected information related to coastal flooding in the absence of a federal presence. Although this may generate useful supplemental data, there was a consensus among contributors that consistent protocols and standards were needed to ensure that these data could be integrated with information collected by agencies such as FEMA and NOAA. These professionals also indicated that state and local emergency and land use planning agencies did not always

consistently collaborate and that NOAA could help foster these linkages through its storm-surge-related activities.

More than 50 percent of respondents to the on-line questionnaire felt that emergency managers either only “occasionally” or “never” worked together with land use planners and Sea Grant/extension agents. Data gathered from all three phases of the needs assessment highlight the need for closer ties between different types of managers. When asked how often emergency managers work together with individuals from the insurance industry on issues related to coastal flooding from storm surge, only 11 percent of respondents stated that they “always” or “often” worked together. Because insurance losses from storm surge flooding can be severe, NOAA may need to investigate ways to increase outreach and communication with these nontraditional partners, whose use of storm surge data and decision-support tools could help minimize these impacts. By strengthening ties with the private sector, NOAA and other federal agencies may be able to increase the utility of their storm surge products and information resources.

III. Key Findings and User Recommendations

The three phases of the needs assessment process highlighted key thematic areas in which users identified major issues, as well as specific needs for storm surge information and decision-support tools. These findings demonstrate both the strengths and opportunities within NOAA's current storm-surge-related activities (See table 1).

Table 1: Principal findings from the NOAA Storm Surge User Needs Assessment

Modeling	Forecast and Decision-support Tools
<ul style="list-style-type: none">▪ NOAA's SLOSH model is the primary source of storm surge data▪ SLOSH's current level of accuracy is sufficient for many state and local managers▪ <i>Areas for improving SLOSH:</i><ul style="list-style-type: none">○ Include wave setup○ Include rainfall/river outflows○ Increase vertical precision to +/- 1 foot○ Model on uniform national grid○ Expand model to inland bays○ Expand extratropical forecasts▪ Storm surge data need to be updated to account for physical and demographic changes along the coast▪ Probabilistic storm surge runs may help users understand forecast uncertainty▪ Additional buoys are needed to provide the necessary baseline tide and water level data▪ Storm surge runs from historical storms could be an effective tool for highlighting risk and vulnerability	<ul style="list-style-type: none">▪ SLOSH outputs are an important resource for emergency decision making▪ Integrating data from various models could improve storm surge forecasts▪ Improving the timeliness of storm surge forecasts to 48 hours before landfall is critical▪ <i>Issues related to vertical datums:</i><ul style="list-style-type: none">○ Users are confused about the datum used for storm surge forecasts○ VDATUM tool is an important short-term resource to convert different types of data○ Storm surge forecasts should use a standard vertical datum (NAVD88)▪ GIS maps, aerial photos, and satellite images are the preferred formats for displaying storm surge information▪ Information about the social and economic benefits of forecast and decision-support tools is needed

Table 2: (Continued)

Communication	Outreach and Training
<ul style="list-style-type: none"> ▪ NWS Weather Forecast Offices effectively communicate storm surge information ▪ <i>Many state and local users are unaware of</i> <ul style="list-style-type: none"> ○ The range of NOAA storm surge products ○ Where to obtain storm surge information ▪ There is a need for increased collaboration among agencies addressing storm surge issues ▪ Graphs and text were considered less effective for communicating storm surge information ▪ Public and private-sector professionals addressing land use and coastal development concerns need improved access to storm surge information ▪ Federal, state, and local managers need information about the public's perceptions of risk and vulnerability to support emergency and evacuation planning ▪ Users and the public are confused about the differences between flood zones in FEMA FIRMs and storm surge maps 	<ul style="list-style-type: none"> ▪ Current outreach and education efforts using SLOSH data need to be expanded ▪ Visualization tools that display potential storm surge impacts are needed ▪ More information is needed about the social and economic impacts of storm surge in order to support outreach and education ▪ Increased outreach to land use planning professionals, insurers, and the marine trades is needed ▪ Outreach is needed to educate policy makers and the public about forecast uncertainty ▪ Increased training about storm surge is needed by emergency, land use, and extension professionals ▪ Training at a local site, along with Web-based and CD-Rom courses, is preferred ▪ National Hurricane Center courses are effective, but most users find them difficult to attend given cost, distance, and limited number of participants

The following sections of this report outline the data gathered directly from users that support these principal findings, as well as many of the recommendations found in the full report. Appendices B and C document the work of the Modeling and Forecast and Decision-support Teams, where a more detailed discussion of high-priority issues and recommendations for addressing needs related to these two areas can be found.

Varying Needs among Emergency Managers and Land Use Planners

Findings from the needs assessment demonstrate the utility of storm surge data for a wide range of coastal and emergency management activities. Respondents to the on-line assessment were asked to identify the management activities where information about storm surge was most critical. Individuals who identified themselves as emergency managers chose either pre-storm planning or emergency response as the most important applications. Alternatively, those respondents who were primarily involved with

planning and extension activities identified a wide range of activities, with nearly half selecting land use planning as the most important application (See figure 8).

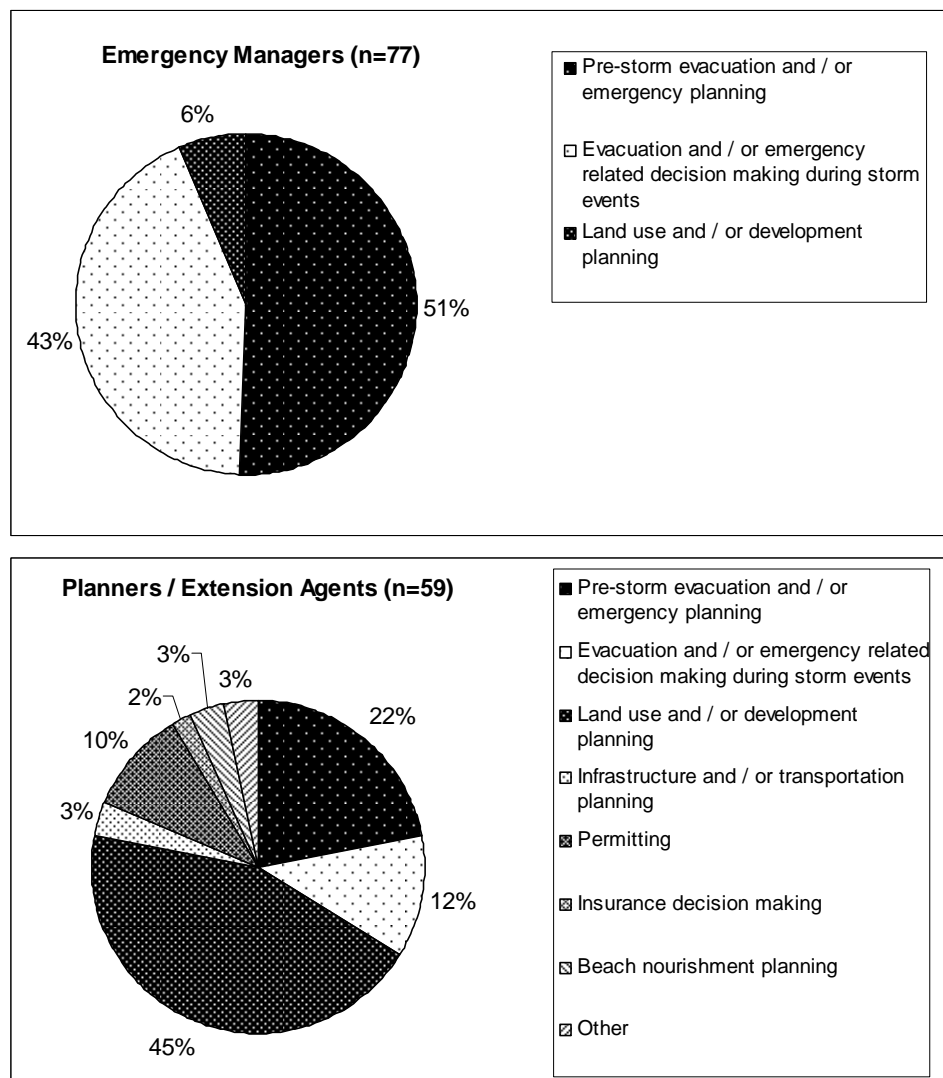


Figure 8: Assessment of the management concerns where storm surge information is most important by user category³

These results illustrate that a broad range of management activities depend on storm surge information. Prioritizing needs solely on input from one user group would not adequately capture the range of management and professional endeavors that rely on high-quality data about coastal flooding from storm surge. This finding highlights the utility of pointed needs assessments that capture these types of nuances when developing new products, services, and management programs.

State and local managers of all types utilize storm surge data and decision-support tools for myriad activities. Nonetheless, many of these professionals are not aware of the

³ Respondents who categorized themselves under land use planning, floodplain/water manager, coastal zone manager, and Sea Grant/extension were combined to create the analytical “Planners/Extension Agents” category for comparison to respondents who identified themselves as emergency managers.

range of data products and services NOAA currently has available. In the near term, adapting existing NOAA storm surge information and decision-support tools to support a wider range of management efforts may be an area where NOAA can provide immediate support and reduce the vulnerability of coastal communities to flooding from storm surge.

Modeling Issues and User Needs

Findings from the needs assessment demonstrate the central role that NOAA's Sea, Lake, and Overland Surges from Hurricanes (SLOSH) modeling effort plays in providing useful information about coastal flooding from tropical and extratropical storms. Seventy percent of respondents to the on-line assessment said that SLOSH was their primary source of storm surge data. Because most managers use SLOSH outputs rather than working directly with the model itself, only general information about modeling needs was gathered through the on-line assessment. During the focus group sessions, participants identified a number of more specific needs for improving storm surge modeling efforts. These needs included the following:

- Drawing upon an ensemble of models to develop storm surge forecasts
- Linking data from rainfall/river models to SLOSH
- Expanding the use of SLOSH for extratropical storm surge forecasts
- Generating a uniform national grid for SLOSH
- Creating an automated way to update basin topography
- Including wave setup in the SLOSH runs
- Adding buoys to increase the water level data available to support SLOSH
- Integrating tides into SLOSH, especially for forecasting extratropical storm surge
- Expanding SLOSH to inland bays and estuaries
- Creating higher resolution models that link to NWS National Centers for Environmental Protection weather and wave models

Effective ways for communicating SLOSH outputs was one of the most extensively discussed topics during the Northeast and Gulf of Mexico focus group sessions. Participants understood the need to err on the side of safety when identifying the areas that would likely be impacted by storm surge. Nonetheless, a number of individuals suggested that displaying only the "worst case scenario" was not always the most effective way to communicate either the risks associated with storm surge or encourage evacuation. They suggested that if forecasts consistently exceeded the actual area flooded, both the public and elected officials would be less likely to heed calls to evacuate during future storms.

This issue of storm "fatigue" was especially of concern in Florida and other southeastern states where coastal communities experience frequent impacts from tropical storms. In addition, many local and state managers are aware that the baseline topographic information used to develop SLOSH forecasts is not accurate for their locales, further reducing confidence in model outputs. This illustrates the importance of coordinating any modeling improvements with efforts to update topographic and bathymetric data.

Data gathered during the assessment process illustrated that probabilistic storm surge forecasts could be a useful tool for emergency managers. Showing surge probabilities may help these professionals coordinate evacuation efforts and improve their ability to communicate the uncertainty inherent in storm surge forecasts. Nonetheless, these respondents cautioned that both the public and elected officials have difficulty understanding weather-related probabilities. Any effort to deliver probabilistic storm surge information would need to be accompanied by a targeted outreach and education effort to ensure that these new data help reduce the impacts on both lives and property from storm surge.

During the focus group sessions, a number of individuals pointed to the utility of data from other storm surge models such as AdCirc for storm-surge-related management activities. They suggested that modelers from NOAA, other federal agencies, and academia establish closer ties and look for ways in which data from different models could be consolidated to create more comprehensive information resources for storm-surge-related decision making. For those users who were directly linked to these modeling efforts, there was support for an approach that would draw upon an ensemble of models to predict and forecast storm surge from extratropical and tropical storms.

Forecast Timeliness versus Accuracy

Some of the most challenging questions encountered during the needs assessment process related to the ability to accurately predict the area that will be inundated and the time horizon in which forecasts can be provided. The timeliness of forecasts affects the ability to plan and implement evacuations before storms hit, while the accuracy helps determine which areas need or need not be evacuated.

Although users recognized the constraints encountered by storm surge forecasters, both respondents to the on-line assessment and focus group participants stated that most evacuation and emergency planning activities must occur two or three days before a storm's arrival. For this reason, improving the timeliness of storm surge forecasts was one of the highest priority needs. When asked how far in advance they needed information about storm surge, nearly 60 percent of respondents said they required this information at least 48 hours before landfall. Data from the focus group sessions and key informant interviews reflected this same time horizon.

There was a widespread concern that tropical storm and storm surge data were not reaching local emergency managers in a timely enough fashion. These professionals noted that most evacuation-related decisions had to be made long before storm surge forecasts were delivered to state and local managers. Respondents indicated that especially vulnerable facilities such as hospitals, homes for the elderly, and ports needed this information 60 to 72 hours in advance to successfully prepare for storm impacts and conduct the necessary evacuations.

When asked whether they would prefer storm surge forecasts to be timely or accurate, 71 percent of respondents who were involved with emergency-related decision making indicated that having storm surge information well in advance of a storm's landfall was more important than knowing the precise area to be flooded (See figure 9).

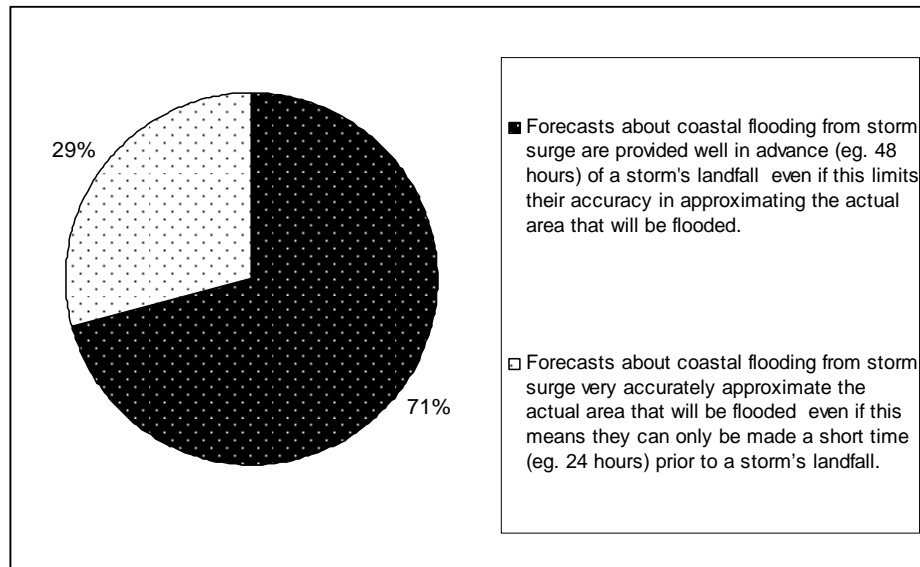


Figure 9: Relative importance of timeliness versus accuracy for storm surge forecasts (n=93)

This need for timely storm surge information was echoed by participants in the three focus group sessions. Nonetheless, 50 percent of respondents to the on-line assessment also stated that they needed information about storm surge to be accurate within +/- 1 foot in terms of height (See figure 10).

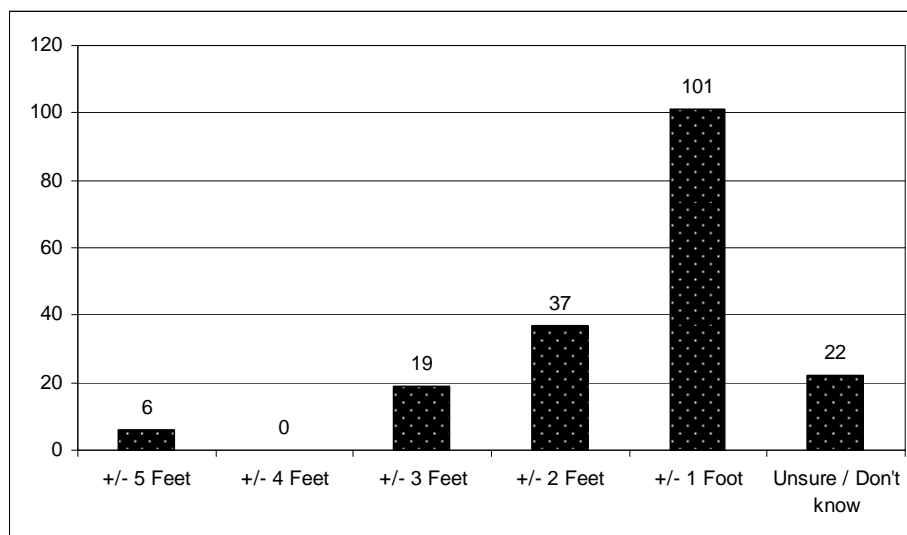


Figure 10: Storm surge accuracy needed in terms of height (n=185)

When asked an additional question about the accuracy needs in terms of inland extent there was no clear consensus among users. This suggests that although timely storm surge information is the most pressing need, more precise data about the height of surge would also support planning and emergency management efforts.

Overall, the needs assessment effort found that most users felt the current accuracy of storm surge information was sufficient, particularly for emergency-related activities.

Nonetheless, a greater degree of precision could have significant positive impacts in land use and planning applications (See figure 11).

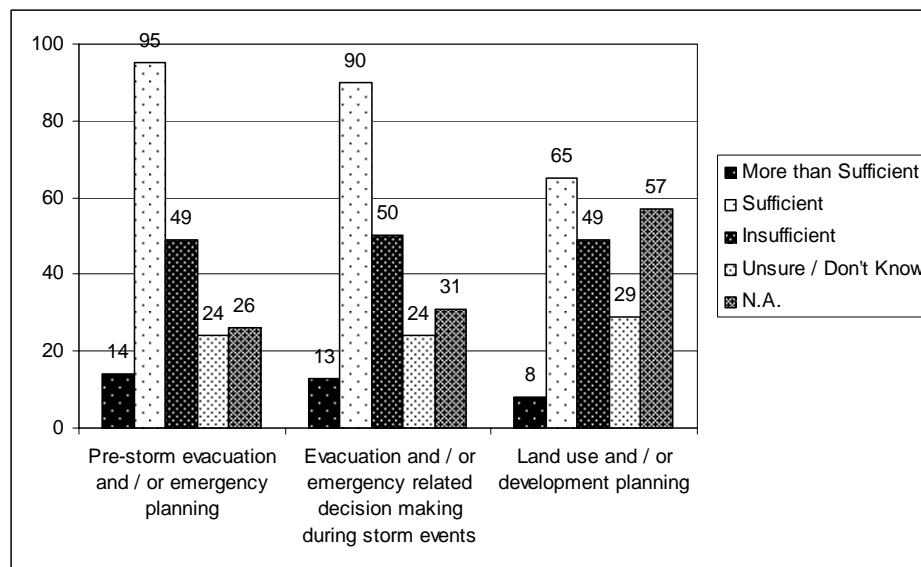


Figure 11: Adequacy of the current storm surge information for different applications (n=208)

During focus group discussions, it was clear that emergency managers were most interested in knowing whether a general area would or would not be flooded. Land use planners were more concerned about precise flood predictions, since a slight difference could influence insurance and land use decision making. Sixty-three percent of respondents involved in planning and extension-related activities indicated that the level of detail found in the current storm surge information was not sufficient for these types of activities.

At present, most flood-related land use decisions are made using FEMA Flood Insurance Rate Maps (FIRMs). Storm surge information from models such as SLOSH has been used to complement FIRM data, but given regulatory requirements it is not used for regulatory purposes. However, given that actual storm surge from tropical and extratropical storms often exceeds the 100-year flood delineation found on FIRM maps, both land use planners and emergency managers indicated that SLOSH data could be an effective tool for communicating risk, encouraging sound land use decision making, and reducing the potential impacts from inundation events on coastal communities.

IV. Decision-Support Issues and Needs

Throughout the needs assessment process, respondents suggested that by developing new ways of packaging and disseminating modeling and forecast information, NOAA could significantly assist in reducing the impacts from storm surge on both people and property. Some of their specific suggestions included the following:

- Incorporating storm surge information into easily portable geographic information system (GIS) layers
- Developing tools that help identify key coastal areas and infrastructure at risk for impacts from storm surge

- Using actual surge information from historical storms to communicate risk and vulnerability to policy makers and the public
- Creating visualization tools that display potential impacts from storm surge to support outreach and planning efforts
- Developing tools for converting between different vertical datums

It is clear that NOAA's storm-surge-related decision-support tools are playing an important role in delivering information about coastal flooding from storm surge. Nonetheless, these successes need to be expanded, and further effort should be directed towards tailoring forecasts, Web resources, and other tools to the specific needs of different users (See figure 12).

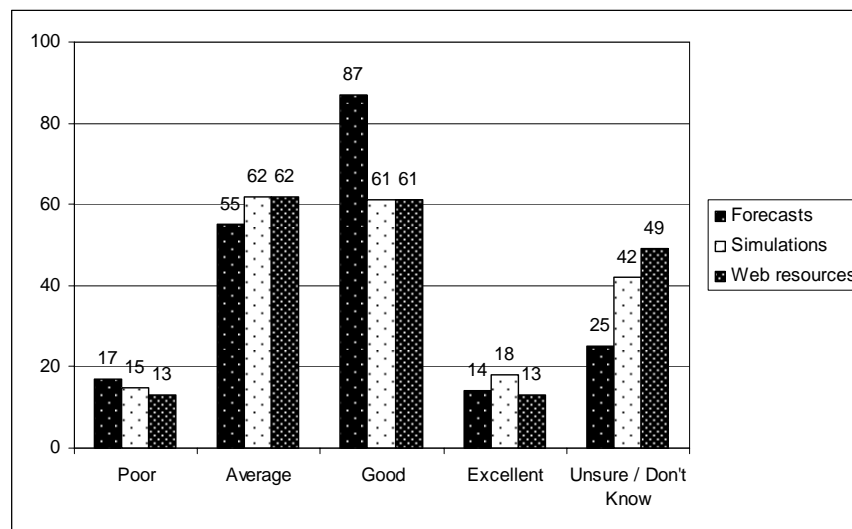


Figure 12: Quality of the current storm surge forecasts and decision-support products (n=198)

The overall assessment effort illustrated that NOAA should carefully assess how the agency communicates storm surge data to ensure that these methods are linked to the needs of different types of managers. Results from the on-line questionnaire show that users look to NOAA for information about storm surge for emergency-related activities. However, FEMA and state GIS databases are the places these professionals go to get storm surge information for land use and development planning (See figure 13).

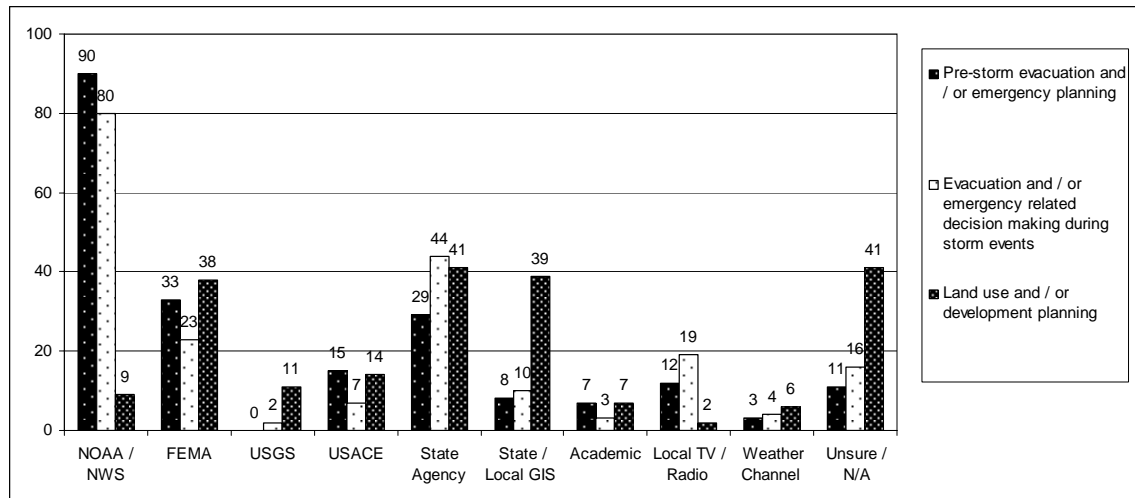


Figure 13: Principal sources for information about storm surge by type of activity (n=208)

Focus group discussions illustrated that many professionals working on land use planning issues are not aware of the range of NOAA products related to coastal flooding from storm surge. These users suggested that NOAA should investigate additional ways for displaying these data and develop new decision-support tools to facilitate the use of SLOSH data to inform planning decisions. NOAA should not replace either FEMA or state agencies as the primary sources for flood-related information for land use planning; rather NOAA's products should complement the tools offered by these other agencies. Users suggested that NOAA could collaborate with FEMA and state managers to develop new ways of integrating both SLOSH data layers and information about historical storms to provide targeted outreach and decision-support tools for land use planning. This would pool the limited resources available to all these agencies and ensure that a variety of users would have access to NOAA storm surge data.

Terminology and Nomenclature

The highly technical nature of storm surge modeling makes it a challenge to communicate outputs in a manner in which a wide range of individuals can understand them. Participants in the focus group sessions stated that confusion regarding the use of different vertical datums decreases users' confidence in NOAA storm surge forecasts. One of the areas that users suggested NOAA could make immediate improvements in its storm surge products was by addressing differences in the vertical datums used when reporting this information. SLOSH outputs are currently based on the National Geodetic Vertical Datum of 1929 (NGVD 29), while most other storm-surge-related data sources use the North American Vertical Datum of 1988 (NAVD 88).

Results from the on-line assessment indicate that displaying information as storm tide or total run-up is the preferred manner to communicate storm surge information (See figure 14). Nonetheless, feedback collected during the focus group sessions suggests that there continues to be debate about the most appropriate way to convey this storm surge data.

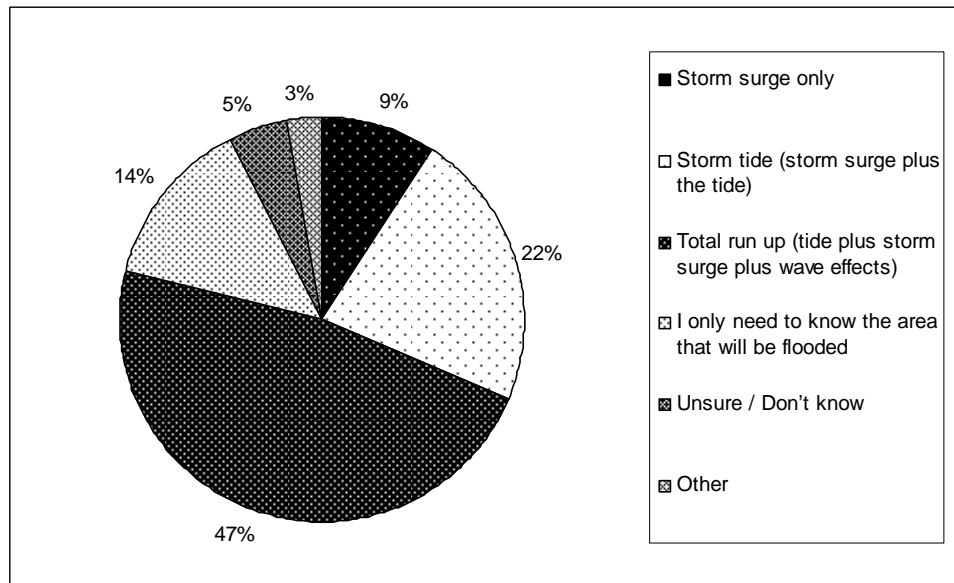


Figure 14: Preferred output for storm surge values (n=191)

As was found in other elements of the needs assessment process, different groups prefer information in different formats. Navigation interests still prefer mean lower low water (MLLW), while floodplain and land use managers need information in NAVD 88. Since collaboration with other agencies such as FEMA, USGS, and USACE will be an important part of NOAA's future efforts related to storm surge, a number of users felt that it would be important for the agency to comply with federal requirements that stipulate the use of NAVD 88. Since this conversion will happen over time, focus group participants indicated that the VDATUM tool could be a very useful mechanism for addressing differences in the datums. They suggested that NOAA expand outreach about the tool and provide training on the use of VDATUM to address the difference in the datums utilized for generating storm surge information.

Displaying and Disseminating Storm Surge Information

Given the different levels of access to computer resources and data repositories within the coastal and emergency management community, the needs assessment team carefully investigated the formats in which users would most like to see storm surge information. Both the on-line assessment and focus groups sessions indicated that GIS maps, aerial photos, and satellite images were the preferred formats, while graphs and text were thought to be not as useful (See figure 15). This suggests that some of the current graphical outputs used by NOAA could be updated to better suit users' needs. When these results were broken down by specific categories of professionals, no significant differences existed between the formats preferred by emergency managers or land use planners.

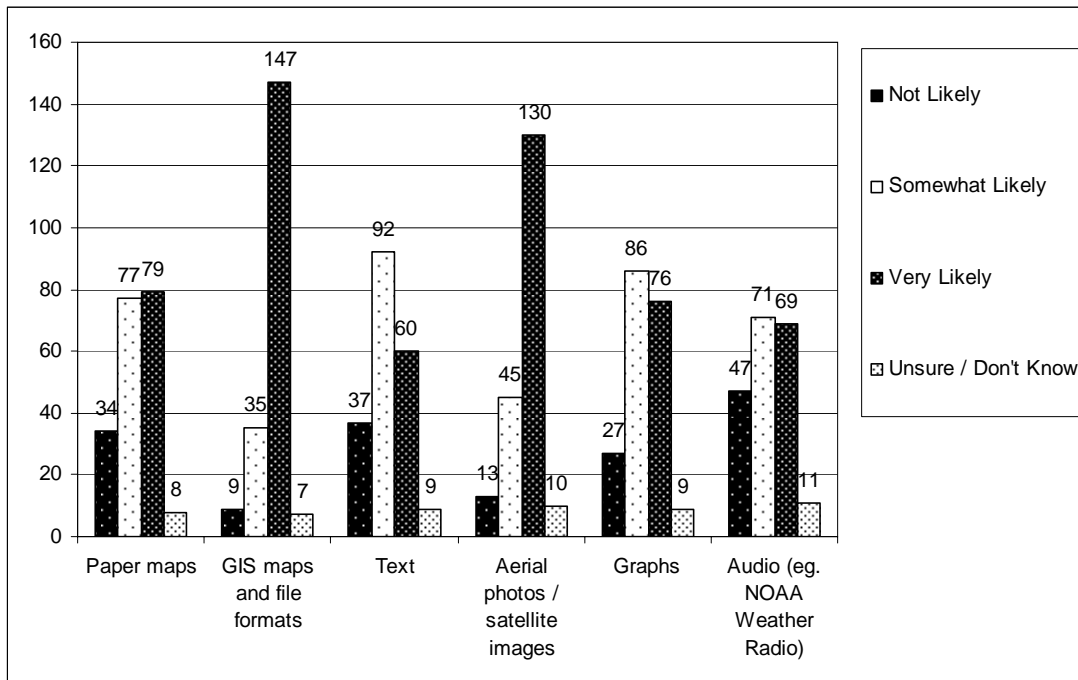


Figure 15: Likelihood that respondents would use storm surge information delivered in different formats (n=198)

These findings highlight the need for NOAA to integrate its various storm surge products and forecasts into GIS layers and other visualization formats. In addition, support should be provided to local and state agencies that do not have sufficient GIS capabilities to ensure that they can utilize these data for both emergency and land use decision making.

V. Outreach, Communication, and Training

Coastal flooding from storm surge directly threatens lives and property in communities across the U.S., illustrating the importance of both training state and local managers to use forecast and decision-support tools and developing targeted outreach and communication products. Eighty-one percent of respondents to the on-line assessment said they were interested in receiving additional training related to storm surge. These professionals clearly prefer having training conducted in their local area, but they also demonstrated support for receiving training via the Web or through CD-Rom/workbooks (See figure 16).

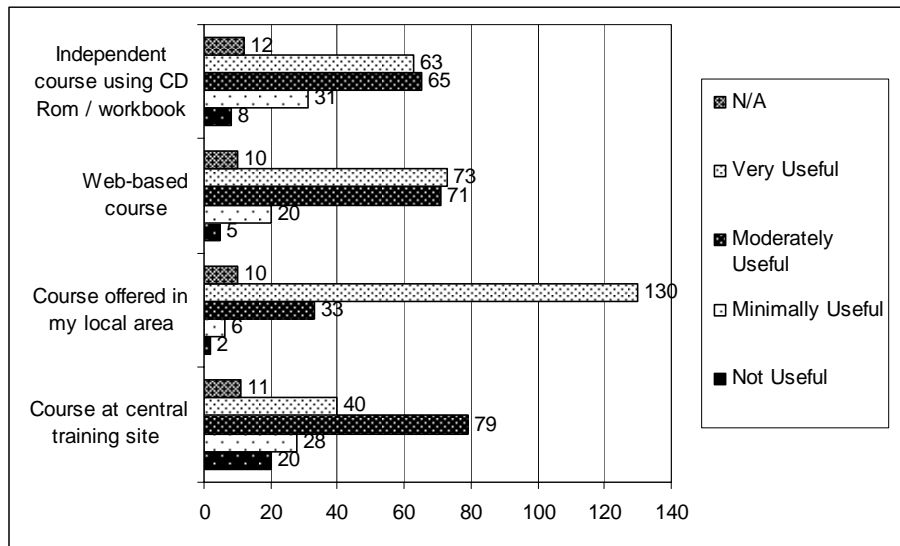


Figure 16: Assessment of the usefulness of different types of training delivery mechanisms (n=181)

Participants in the focus group sessions echoed the need for additional training and emphasized that not only emergency managers should have access to this training, but also land use planners, the media, and representatives from marine trade organizations.

Forty-eight percent of respondents to the on-line assessment stated that they had received some type of training related to storm surge. These data suggest that there is a significant amount of unmet demand for storm-surge-related training. Users suggested that NOAA examine ways to coordinate its capacity-building efforts with other federal, state, and local agencies to ensure that all types of managers have the skills necessary to utilize NOAA-generated storm surge information and decision-support tools.

Focus group participants who had attended training sessions at the NWS National Hurricane Center gave them high ratings. However, only 25 percent of respondents to the on-line assessment had attended the training offered at the NWS National Hurricane Center. The financial cost and time away from the office were cited as barriers limiting users' participation in these courses. The training efforts of NWS regional WFOs were consistently cited as very effective in developing local capacity to understand and apply storm surge information for emergency-related decision making. Future efforts should build upon these successful activities.

In terms of the content, findings from the needs assessment process also highlight a need for training on developing outreach activities, so managers can better communicate storm surge data and forecasts to the public. Respondents emphasized the importance of developing unique training modules for elected officials and the media, since these individuals play pivotal roles in both planning and emergency decision making. Many focus group participants felt that using visualization tools and developing outreach materials that draw upon data from historical storms would be effective ways to communicate the potential impacts from storm surge.

VI. Assessing Users' Needs

Finally, it is important to note the large number respondents to the on-line assessment who voiced their support for the needs assessment process in general. This positive

feedback was echoed by focus group participants and illustrates a consensus that NOAA should continue to directly engage the users of its products and services as it seeks to develop new information resources and decision-support tools. Findings from the needs assessment suggest that federal agencies may not fully understand all the needs of their customers unless they communicate directly with state and local managers. In addition, the process of conducting this needs assessment helped strengthen ties, not only between NOAA and the users of its storm surge information, but also among state and local coastal and emergency management professionals.

In both the Gulf of Mexico and the Northeast, participants in the focus group sessions voiced an interest in further collaboration and a desire to establish closer regional ties. The needs assessment will not only help managers around the country understand the range of issues and needs related to coastal flooding from storm surge, but it will also illustrate areas where increased cooperation could strengthen existing management activities. In this way, the work of the NOAA Storm Surge User Needs Assessment Team helped forward the improvement of storm-surge-related management by identifying key areas for NOAA to direct its internal technical resources while also supporting improved collaboration among the range of professionals working to minimize the impacts of storm surge on coastal communities.